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Hybrid Onions

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SUMMARY

The development of hybrid onions makes possible greatly increased efficiency in production by reducing field and storage losses, improving quality and yield, and increasing the uniformity of size, shape, and maturity.

Certain hybrids, now being grown in the South, are showing great resistance to disease, grading nearly 100 percent U.S. No. 1's and increasing the grower's return per acre by \$500 at average prices. Northern hybrids are just reaching grower's fields in quantity but they have already demonstrated their ability to cut losses in storage, increase yield, and resist harvest damage.

New hybrids will soon be available to commercial and home gardeners in every section of the country, and additional research is underway to develop even better crossings.

The development of the hybrid technique in onion breeding makes possible the production of plants that are adapted to any combination of growing conditions and which meet specific needs of growers.

HYBRID ONIONS

Hybridization of onions, like that of corn, is greatly increasing the efficiency of American growers. Some of the newer hybrids have demonstrated their ability to increase returns by as much as \$500 an acre.

The story of hybrid corn has been told so often that few people are completely unaware of its effect on the agricultural economy of the Nation. From a small beginning in 1933, the use of corn hybrids has mushroomed until today 87 percent of the Nation's corn acreage is planted with hybrid seed. During the mid-years of World War II farmers were able to meet a greatly increased demand for corn from 30 million fewer acres than during the same period in World War I.

The story of hybrid onions, however, is known to only a few, despite the fact that hybrids have increased efficiency of onion raising and returns per acre to a much greater degree than have corn hybrids. The onion hybrid Granex has shown a 94 percent increase over Texas Early Grano, the variety most commonly planted in the extreme South before 1952. This increase of 360 fifty-pound bags means an income increase of \$540 an acre, at the 10-year average price of \$1.50 a bag. Other hybrids have increased efficiency in a comparable manner by making possible earlier harvesting, greater uniformity of size, shape, and maturity, and greater resistance to disease.

THE DAVIS DISCOVERY--THE BASIS

The discovery in 1925 of an all-female plant in onion breeding plots at the California Agricultural Experiment Station at Davis¹ provided the mother for all of today's hybrids. Onion plants bearing all-female flowers are very rare. Even more rare is an all-female plant of a seed-producing variety that also forms top sets, making possible the continuance of a pure all-female strain. The Davis, Calif., discovery was doubly rare--it fitted both requirements. In succeeding plantings, it was found that this onion could reproduce itself indefinitely with top sets, and that it would also produce a good supply of seed if the flowers were fertilized by pollen from another plant. This opened the way for controlled hybridization and made unnecessary the impracticable emasculation that had prevented development of commercial hybrids.

The discovery of the all-female plant--designated Strain 13-53--did not mean that desirable commercial hybrids could then be turned out on a production line basis. The all-female plant was of the Italian Red variety; hybrids bred from it were red in color; and the demand for red onions is limited. Female plants in white and yellow varieties, in early and late varieties, and in storage types were needed before hybrids of all commercial types could be made available.

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HYBRIDS PRODUCED TO DATE

A number of hybrids have been produced to date. The first of these was released in 1944 and the majority in 1953.

Although the Davis discovery was made in 1925, commercial hybridization was not feasible for some 20 years. Genetic principles had to be worked out, and basic breeding lines possessing the desired characteristics had to be developed first.

The first commercially acceptable hybrid, California Hybrid Red No. 1, was produced in 1944. Its mother was the vegetatively increased, all-female plant discovered at Davis in 1925. Its father was a male inbred line of Lord Howe Island. The hybrid offspring yielded as much as 1,462 fifty-pound bags per acre, which was greatly in excess of the yields of either parent. In addition, it combined the early maturity of the Lord Howe Island with the delayed seeding habit of the Italian Red.

At the same time California Hybrid Red No. 1 was being developed, work was being carried on with yellow and white onions in the early varieties, and in storage types. Since the female parents had to be developed from Italian Red 13-53 females, the red color was bred out and other characteristics bred in.

Strain 13-53 plants were crossed with a certain genetic type of high-producing male plants of various colors and varieties. In some of these crosses, all plants of a progeny were female. These females were backcrossed with the same male parent, and selected females in resulting successive generations were again backcrossed with the same male line. After 5 or 6 generations the females were very similar to the male parents in appearance. All-female plants, having the desired colors and characteristics were then available for hybrid production. Since each generation required one or two years to produce seed, the process was time-consuming.

Once all-female plants were produced, they could be continued by crossing with a related male inbred line. But to produce onion hybrids, the all-females had to be crossed with a second male inbred line (Figure 1). Therefore, 3 parent lines had to be maintained in order to produce hybrid seed.

In 1952 the yellow hybrid Granex was introduced. It is adapted to the extreme South. Its ability to produce high yields, its general attractiveness, and its mild flavor has caused commercial growers of yellow Bermuda-type onions to shift more and more of their acreage to Granex.

The following year a number of Northern hybrids were released. All were high yielders and were resistant in varying degrees to various onion diseases. The major hybrids available today, their geographical adaptation, and their important characters are presented in table 1. Those hybrids that have been or soon will be replaced by superior ones are not included in the table.

In addition to those in table 1, a number of onion hybrids have been produced by commercial seedsmen from the all-female lines developed by Dr. Jones.

Table 1.—Available Onion Hybrids Developed by the United States Department of Agriculture and Cooperating State Agricultural Experiment Stations.¹

Location and name	Year introduced	Introduced by—	Bulb color	Bulb firmness	Storage	Maturity	Geographical adaptation
SOUTHERN (Mild) HYBRIDS							
Granex ²	1952	USDA and Texas	Yellow	Soft	Short	Early	Extreme South.
NORTHERN (Pungent) HYBRIDS							
Champion	1953	USDA, New York, Iowa, and Idaho	Dark yellow	Firm	Medium	Late	Northern States from Washington and Oregon east through New England.
Contender	1953	USDA, Iowa, and Idaho	Light yellow	do.	Short	do.	Do.
Elite	1953	USDA, Indiana, Iowa, and Idaho	Yellow	do.	Long	do.	Do.
Encore ²	1953	USDA, Iowa, and Idaho	Dark yellow	do.	Medium	do.	Do.
Abundance	1953	do.	Light yellow	Soft	do.	do.	Do.
Aristocrat	1953	USDA, Ohio, Iowa, and Idaho	Yellow	Very firm	Long	do.	Do.
Bonanza	1953	USDA, Iowa, and Idaho	do.	do.	do.	do.	Do.
Early Harvest	1953	USDA	Light yellow	Soft	Short	Early	Do.
Epoch ²	1953	USDA, Iowa, and Idaho	Very dark yellow	Very firm	Long	Medium	Do.
Fiesta ²	1953	USDA, Idaho, and Iowa	Copper yellow	do.	do.	Late	Southwest Idaho, Eastern Oregon, and Sweet Spanish Region. ³
Pioneer	1953	USDA, Colorado, and Idaho	Very dark yellow	do.	do.	Medium	Western slope of Colorado, and the Northwest.
Surprise	1953	USDA, Iowa, and Idaho	Dark yellow	do.	do.	Late	Northern States from Washington and Oregon, east through New England.

¹List does not include those hybrids which have been replaced, or which will soon be replaced by superior varieties.

²Seed available to growers in 1956.

³Sweet Spanish region located in parts of the West Coast and Rocky Mountain States.

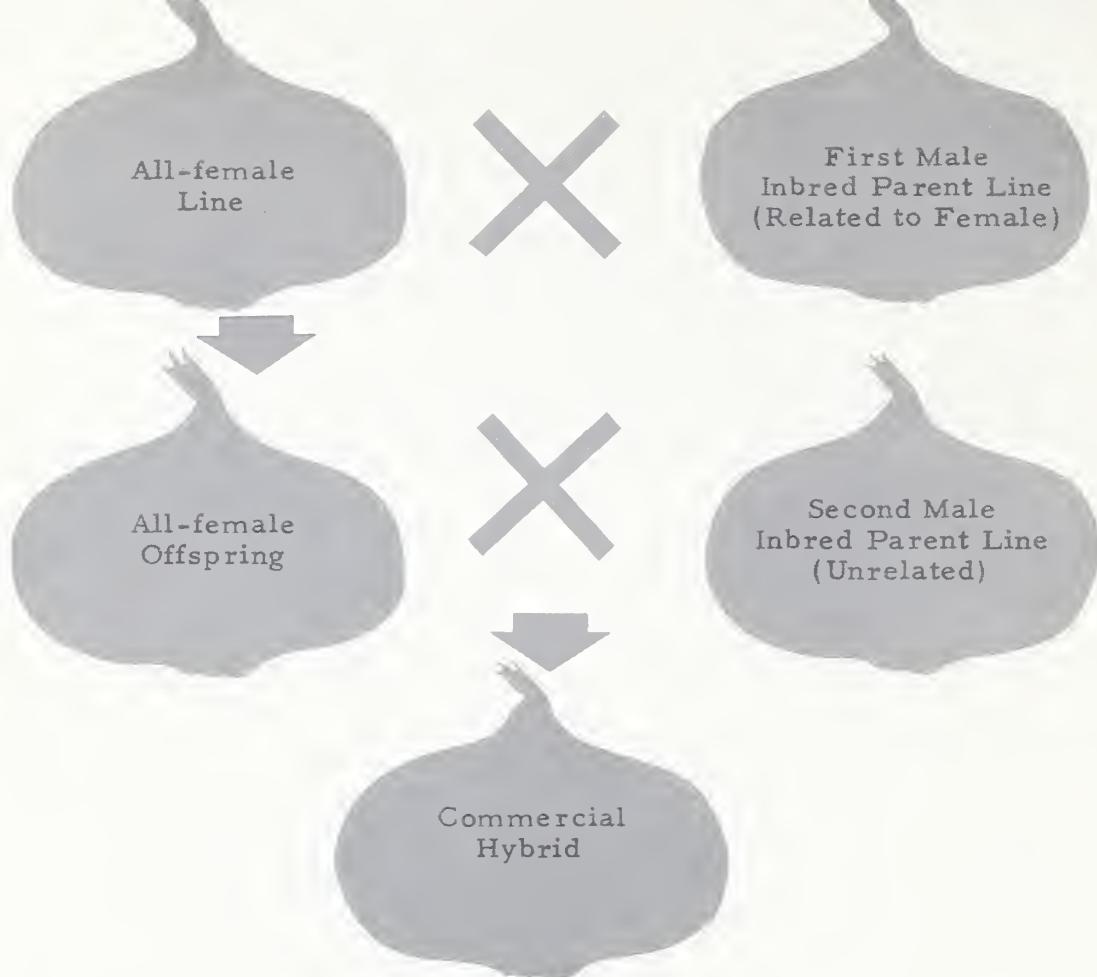


FIGURE 1--Three lines are required to produce the onion hybrid. Crossing the all-female and the first male lines produces the all-female offspring. Crossing the all-female offspring and the second male line produces the hybrid. So-called male lines are normal, bisexual plants capable of self-perpetuation.

BREEDING ACHIEVEMENTS

Increased yields, through hybrid vigor and disease resistance, is one of the most spectacular breeding achievements of the hybridization program. Early maturity, uniform maturity, shape, color, and edible quality, and low percentage of culls may be less spectacular achievements, but may prove equally important.

Resistance to Field Diseases

The two major field diseases of onions are downy mildew and pink root, but high losses are also suffered in particular areas from attacks of purple blotch.

Downy mildew, one of the most destructive onion diseases, attacks both the bulb and the seed crop. It usually occurs late in the growing season and covers the leaves with a fungus coating that has, on occasion, destroyed as much as 80 percent of the seed crop. In 1934 it was found that Italian Red strain 13-53, which made such outstanding contributions

to hybridization, was almost completely resistant to mildew. A degree of its resistance was passed over into California Hybrid Red No. 1, and resistance is now being incorporated into other hybrids.

Pink root is a serious disease that is found in most onion-growing areas and is particularly destructive in the extreme South. It is caused by a soil-borne fungus that destroys the roots of the plants. This so reduces the feeding capacity of the plants that yields are greatly reduced and bulbs at harvest may be too small to sell.

Attempts to breed plants resistant to pink root resulted in the introduction of the Excel variety by the U.S. Department of Agriculture in cooperation with the Texas and California Agricultural Experiment Stations in 1945. Excel was highly resistant to pink root and, on pink-root-infected soil, yielded considerably higher than Texas Early Grano or Yellow Bermuda, the varieties most commonly planted at the time in the extreme South. Efforts to produce resistant hybrids resulted in the introduction of Granex in 1952 by the Department and the Texas Agricultural Experiment Station. In field tests on infected soil, it yielded 32,600 pounds more per acre than the susceptible Texas Early Grano, and 11,500 pounds more than the highly resistant Excel variety. Despite its high yield, Granex is not completely immune to pink root. Scientists, however, have recently discovered how resistance to the disease is inherited. This new knowledge will greatly facilitate the development of hybrids completely immune to pink root.

Purple blotch is most prevalent in certain areas of the Northern and Western States where Spanish-type onions are produced. The Northern storage varieties and hybrids are highly resistant to purple blotch, and this resistance is now being incorporated into the Spanish-type hybrids.

Resistance to Storage Diseases

Hybrids released in 1953 are adapted to late-harvesting areas, where most of the crop goes into storage. These are highly resistant to storage diseases such as neck rot. The majority of them are firm-fleshed and have scales that adhere well. In addition to their higher-yielding ability, they are less susceptible to rotting and sprouting than the standard varieties.

Resistance to Insects

Onion thrips are one of the few insects that attack onion plants. However, this louse-like insect, which is only a twenty-fifth of an inch long, causes considerable leaf damage and greatly reduces yields.

In searching for a variety resistant to thrips, plant breeders determined the characters that either reduce the number of thrips per plant or cause the plant to show less injury. One of the most advantageous of these characters is the one that causes glossy foliage. Most onion plants secrete a waxy layer or "bloom" that gives a grayish cast to the leaf. It is easily rubbed off. When this waxy covering is absent, the foliage has a glossy appearance. In all field tests, glossy plants showed a considerable resistance to thrips. Unfortunately, they possessed little resistance to disease. A method of breeding onion hybrids that was resistant to both was found, but the discovery of DDT and other effective insecticides

reduced the urgency of the need for a thrip-resistant plant, and glossy foliage research was suspended in order to concentrate on more pressing problems.

Other Breeding Achievements

All of the hybrids that have been released produce a very large percentage of U.S. No. 1 onions. Crops of standard varieties often contained as high as 50 percent culls. Hybrids, on the other hand, often yield only 1 to 2 percent culls.

Uniformity of maturity is an advantage of increasing importance. Greater use of mechanical harvesting methods necessitates uniform maturity of all onions in a field. Uniform size and shape of the bulbs facilitate machine handling, and firm-fleshed bulbs with tight scales are less subject to harvesting damage and handling losses during storage.

Despite these achievements, onion breeders are developing hybrids of additional types and improving the hybrids already released.

SEED MULTIPLICATION FOR COMMERCIAL USE

Once a desirable hybrid is produced, the quantity of seed of the 3 parent lines (see Figure 1) must be increased to meet the demand of commercial seedsmen. The seedsmen, in turn, increase their stock to the point where they can produce sufficient hybrid seed to satisfy anticipated grower demand.

Increasing of the 3 parent lines is accomplished in the same manner whether undertaken by the original hybrid breeder or the commercial seedsman. The all-female line is continued and increased by crossing it with the related male parent (the first male inbred line). The two male parent lines reproduce themselves since the plants used as a source of pollen are actually bisexual. Finally, the commercial seedsman crosses the all-female line with the second male parent line to produce the hybrid.

Increase of Seed Lines in Cages

During the first increase of seed lines, every precaution possible is taken to prevent any mixing among the 3 seed lines or with other onions. The 2 lines used to perpetuate the all-females (the female and the first male parent line) are raised in insect-proof cages. The female lines are planted in narrow blocks of 3 or 4 rows alternating with 1 row of the male line. Seeds borne on the all-female plants will also be all-female, and the seeds of the male parent plants will be bisexual. In these cases, pollen from the male inbred parent line fertilizes the all-female plants as well as themselves, and seed from these 2 lines are produced in the same cage.

The second male line, which will be crossed with the all-female line to produce the hybrid, is planted in separate cages. These plants fertilize themselves.

In all the cages, pollination is accomplished by bees which are introduced just before the flowers open. All off-type plants are removed daily, and female plants that appear to be producing male, pollen-bearing

organs are also pulled out. To prevent the transfer of pollen from one cage to another, clothes worn by workers are brushed carefully before entering, and their hands are sterilized with alcohol. A large cage may produce up to 5 pounds of seed.

Increase of Seed Lines in the Open

The first increase of seed lines in the open is undertaken after a good supply has been produced in cages. In the field some contamination will occur, but it can be minimized by isolating individual fields. Since a smaller percentage of contamination occurs in large fields, blocks of at least 1 acre should be used for each planting.

Again the all-female line and the first male line are planted in the same field, and in alternate blocks of 2, 3, or 4 rows. The second male line is planted in a separate field. All plots are rogued daily during the flowering period to remove undesirable plants. Pollination is accomplished by bees, and three or four hives are used per acre. Native insects may also do considerable pollinating.

Sufficient stock seed for a 3- or 4-year production of a particular hybrid may result from the first field increase, but if a second increase in the open is necessary, the same precautions should be taken.

In producing hybrid seed, only two lines are crossed. These are the all-female line and the second male parent line, which is an inbred. The first male line is only used to perpetuate the all-female line and itself.

The two lines that are crossed to produce hybrid seed are planted in the open. The rows are alternated--4 rows of female plants followed by 1 row of males. Pollination is again carried on by bees and the same precautions taken as for field increases of seed stock. The female plants should also be rogued to remove those producing pollen. If this is not done, the hybrid seed will contain some self-pollinated seed, which will produce plants different from those from hybrid seed. This seed is then sold for commercial bulb production.

The process of field crossing the two parent lines must be carried out for each lot of hybrid seed. Seed grown from hybrid onions is not suitable for commercial planting.

THE ONION OUTLOOK

Research workers are in position to know what the hybrids of the future will be many years before they can be put into commercial production. Their experimental hybrids today are the commercial hybrids of tomorrow.

In the near future, hybrids will be released for growers of white onions and for the home gardeners. Seeds of hybrids already released will become available to a greater number of onion growers, and hybrid onion acreage will increase markedly.

In the longer run, hybrids will bring about numerous changes in onion production as they crowd out the standard varieties. These can best be evaluated on a regional basis.

Changes in the South

The changes that are occurring in the onion industry in southern Texas are indicative of what can be expected elsewhere. Since 1946 the old Yellow Bermuda and Crystal Wax varieties have been largely replaced by new varieties, and they, in turn, are being largely replaced by hybrids.

The first of these hybrids, Granex, was introduced in southern Texas in 1952. Granex is a tremendous yielder, is one of the mildest onions on the market today, can be brought to maturity early in March, and stores well for a southern type. It produces good yields on soil infected with pink root. Further breeding work on this hybrid should, within a few years, make it almost completely resistant to this disease.

In 1952 the white Crystal Hybrid was also introduced. Its superiority to standard white varieties brought about its rapid acceptance by onion growers, but a new white hybrid, as yet unnamed, has since been produced. Although more subject to injury from sun and rain than a yellow onion, it combines the high yielding ability and the mild quality of the yellow Granex. Parent lines have been supplied commercial seedsmen and they are currently increasing seed to meet the anticipated demand of growers.

As a result of the introduction of hybrids in the South, onion harvest can extend over a longer period and yields will be heavier.

Changes in the North

Hybrids have only recently been introduced in the North and their impact on production is not yet as marked as in the South. Breeding work with southern varieties can proceed faster than with northern varieties which require 2 years for each experimental generation. Generations in the South can be completed in a single year.

In 1953 a number of northern hybrids were released as shown in Table 1. Aristocrat, Bonanza, Epoch, Elite, and Surprise are all firm-fleshed onions which withstand mechanical harvesting and handling, and store very well. Tests in New York and in other northern States have usually shown yields to be in excess of 1,000 fifty-pound bags per acre, with low storage losses by February and seldom more than 10 percent by March. Seed for hybrid production has been released to commercial seedsmen, but it will be at least 2 years before this seed can be increased sufficiently to meet demand.

Pioneer is another long-storage hybrid. It is adapted to the Western Slope of Colorado rather than to eastern United States. Yield is often in excess of 1,000 fifty-pound bags per acre. Mountain Danvers, the variety which Pioneer is replacing, rarely yields over 750 fifty-pound bags per acre. An adequate supply of Pioneer seed will probably be available to growers in another 2 years. Additional high-yielding hybrids are being developed for this area.

Another group of northern hybrids, Abundance, Encore, and Contender, are designed for sale directly from the field or from temporary storage. They will store several months but cannot normally be held until late spring. In some areas they outyield the long-storage hybrids and will be preferred where the crop is stored only a few months. Adequate quantities of this seed will probably be available by 1957 or 1958.

A new hybrid, Early Harvest, has also been released for northern growers who produce intermediate-crop onions. At present, onion sets are planted early in the spring and the bulbs harvested in July and early August. This method of production is costly. This new hybrid is designed to cut production costs. Early Harvest seed can be planted at about the same time sets of standard varieties are planted, but it can be harvested at about the same time as set-planted onions. The new hybrid has other advantages, too. Seedlings emerge quickly and grow rapidly in the early stages. Top growth is small, and the neck is small and refined, making possible its harvest while the hybrid is rather immature. It is milder in flavor than varieties such as Ebenezer, which are grown from dry sets. The yields are good, and the plant is not subject to bolting.

A number of other hybrids of this type are being developed.

Changes in the West

Changes in onion production in sections of the West Coast and Rocky Mountain States where Sweet Spanish onions are grown have not yet been as great as in the South, since the hybrids thus far available lack significant yield advantages over Sweet Spanish varieties. Hybrids have been developed, however, which produce high yields more consistently, are more resistant to disease, and suffer much less shrinkage in storage.

Fiesta is the first of these hybrids. It is specifically adapted to southwest Idaho and eastern Oregon, but it can be grown wherever Sweet Spanish onions are adapted. Fiesta yields are similar to those of Sweet Spanish, but the hybrid is more resistant to purple blotch and stores better.

Across the Nation

Problems of commercial onion producers across the nation differ regionally. Hybrid onions have been developed to meet regional needs and are tailored for conditions that exist in a particular area. Defining the adaptation of hybrids is nevertheless difficult because of the changes in climatic conditions from year to year. Northern hybrids, for example, may be grown in any of the States from Washington and Oregon east through New England. Yet a particular hybrid may do better one year than another in any State because of changes in weather conditions. For that reason, no section of the country should depend upon only one hybrid. Several should be grown that fit the soil and climatic conditions of a particular area.

Problems of home gardeners, however, are rather similar across the country. Home gardeners need a hybrid that has a fairly broad planting range, grows quickly, is resistant to disease, can be used as a green onion or allowed to bulb, produces few culls, and has less tendency to bolt.

Home gardens are usually planted with sets or transplants rather than seed. Production of onion sets has become a sizeable industry in areas around Chicago, Ill., Greeley, Colo., Louisville, Ky., and a few other cities. Transplants are produced in the southern States, where about 100,000 pounds of seed are planted each winter to produce plants for northern growers.

ARS scientists have developed a new hybrid that produces a superior onion, meets the needs of the home gardener and has appeal to the grower of transplants because of its rapid emergence and hybrid vigor. Hybrid transplants, in adequate supply, will probably be available to home gardeners in the spring of 1957.

Other hybrids are in the making that may be helpful to the home gardener, but the greatest impact of onion hybrids will naturally be felt by the commercial onion raiser. Only a small percentage of the onion acreage of the nation is planted to hybrids at the present time, but the percentage is growing rapidly. As soon as sufficient seed can be produced, hybrids will replace standard varieties to a large extent. Hybrid onion acreage will follow the rising trend of hybrid corn acreage, and similar contributions to agricultural enterprise can be expected. Increases in yield, reduction of field and storage losses, and more uniform maturity will result in increased efficiency of production.

